EUROPEAN UNION GOVERNMENT OF ROMANIA SERBIAN GOVERNMENT Structural Funds 2007-2013 ENVIROBANAT Common History, Common Future

GAUSSIAN DISTRIBUTION IN THE NUMERICAL MODELING OF PROPAGATION OF AIR POLLUTION

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- Air pollution modeling is a numerical tool used to describe the causal relationship between emissions, meteorology, atmospheric concentrations, deposition, and other factors.

- Air pollution models are the only method that quantifies the deterministic relationship between emissions and concentrations/depositions, including the consequences of past and future scenarios and the determination of the effectiveness of abatement strategies.

GAUSSIAN PLUME MODEL

- One of the first challenges in the history of air pollution modeling

- This model was applied for the main purpose of calculating the maximum ground level impact of plumes and the distance of maximum impact from the source. Gaussian-plume models are widely used, well understood, easy to apply, and until more recently have received international approval.

- The model was formulated by determining experimentally the horizontal and vertical spread of the plume, measured by the standard deviation of the plume's spatial concentration distribution.

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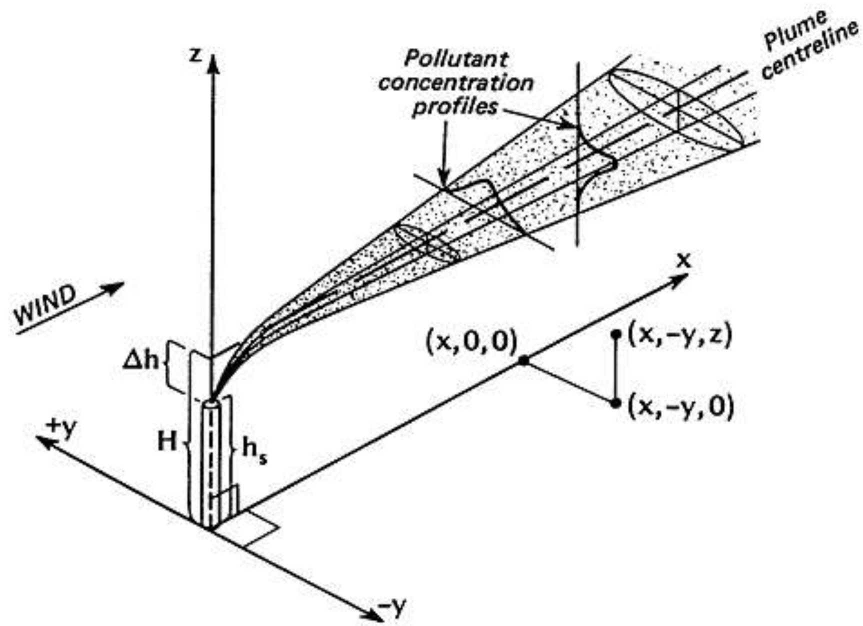

Gaussian plume

$$C(x,y,z,t)=\frac{M}{(2\pi)^{\frac{3}{2}}\sigma_x\sigma_y\sigma_z}\exp\left[-\frac{1}{2}\left(\frac{(x-x'-\bar{u}(t-t'))^2}{\sigma_x^2}+\frac{(y-y')^2}{\sigma_y^2}\right)\right]\left[\exp\left(-\frac{(z-z')^2}{2\sigma_z^2}\right)+\exp\left(-\frac{(z+z')^2}{2\sigma_z^2}\right)\right]$$

C (x, y, z, t) – the pollutant concentration at receptor point (x, y, z) and time (t)

ΔM – the mass of pollutant released from the emission source at the point (x`, y' ,z')at time t', 0< t'<t

σ_x , σ_y , σ_z , - standard deviations of the concentration distribution in the puff in the direction of the OX, OY, OZ axis respectively

ū – average wind velocity

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PRACTICAL EXAMPLES GAUSSIAN MODEL

- **AUSPLUME and ISCST3**

AUSPLUME (which was derived from ISCST2) has enjoyed the status of being the de facto standard Gaussian-plume model. Both models are and will remain particularly useful as screening models (which can be used to determine whether more advanced modeling is required or not), and for small, steady-state, near-field applications.

- **AERMOD**

AERMOD was developed in 1995, reviewed in 1998 and formally proposed by the US EPA as a replacement for ISCST3 in 2000. AERMOD is a steady-state plume model. In the stable boundary layer (SBL), the concentration distribution is assumed to be Gaussian in both the vertical and horizontal. In the convective boundary layer (CBL), the horizontal distribution is assumed to be Gaussian, but the vertical distribution is described with a bi-Gaussian probability density function.

- **CALPUFF**

Accepted by the US EPA as a guideline model to be used in all regulatory applications involving the long-range (>50km) transport of pollutants. CALPUFF is a multi-layer, multi-species non-steady-state Gaussian puff dispersion model which is able to simulate the effects of time- and space-varying meteorological conditions on pollutant transport/

- **TAPM**

Simulate three-dimensional meteorology and pollution dispersion in areas where meteorological data are sparse, or non-existentThe applications that TAPM are designed for are very similar, as both are intended for regulatory impact assessments (among other things).

LIMITATIONS OF GAUSSIAN-PLUME MODELS

- Causality effects
- Low wind speeds
- Straight-line trajectories
- Spatially uniform meteorological conditions
- No memory of previous hour's emissions

Lagrangian models

- Models calculate the diffusion characteristics by the generation of semi random numbers they are not confined by stability classes or sigma curves, as is the case with Gaussian dispersion models.

- Lagrangian models are similar to box models in that they define a region of air as a box containing an initial concentration of pollutants.

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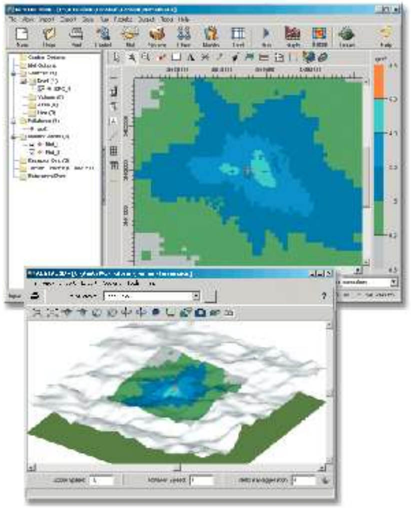
PRACTICAL EXAMPLES LAGRANGIAN MODEL

AUSTAL
The AUSTAL2000 model was developed according to Germany's air pollution control regulation
AUSTAL2000 is a Lagrangian particle tracking air dispersion model that contains its own diagnostic wind field model (TALdia).
AUSTAL View is available in three versions (T, G, and TG) and an add-on module



AUSTAL View

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CONCLUSION

- Gaussian-plume models play a major role in the regulatory arena

- The meteorological conditions are assumed to remain constant during the dispersion from source to receptor, which is effectively instantaneous
Due to this mathematical derivation, it is common to refer to Gaussian-plume models as steady-state dispersion models.
- In practice, however, the plume characteristics do change over time, because they depend on changing emissions and meteorological conditions

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Thank you for your attention